

What is claimed is:

Independents 1, 25, 42, 44

1. A method of correcting engine performance in response to assembly deviations, the method comprising the steps of:

measuring a physical characteristic of the engine; and

5 storing data responsive to said step of measuring in a computer.

2. The method of claim 1, wherein there is further provided the step of operating the engine in response to the stored data.

3. The method of claim 1, wherein the stored data corresponds to deviation information responsive to deviation of a physical characteristic of the engine from a
10 determined norm.

4. The method of claim 3, wherein there is further provided the step of varying an operating characteristic of the engine during operation in response to the deviation information.

5. The method of claim 1, wherein the engine is an internal combustion
15 engine having a plurality of cylinders, the computer is an engine control module, and the stored data has a plurality of data portions corresponding to the physical characteristics of respectively corresponding ones of the cylinders, and there is further provided the step of operating each of the plurality of cylinders of the internal combustion engine in response to the respectively corresponding portions of the stored
20 data.

6. The method of claim 1, wherein the engine is an internal combustion engine having a plurality of cylinders, a crankshaft rotatively coupled to a corresponding plurality of pistons, and a cam shaft coupled to the crankshaft for operating a valve, and said step of measuring a physical characteristic of the engine
25 comprises the further step of measuring a physical characteristic associated with each cylinder of the multi-cylinder internal combustion engine.

7. The method of claim 6, wherein said step of measuring a physical characteristic associated with each cylinder of the multi-cylinder internal combustion engine comprises the further step of measuring a rate of injector fuel flow for each

cylinder of the multi-cylinder internal combustion engine as a function of angle of crankshaft rotation.

8. The method of claim 6, wherein said step of measuring a physical characteristic associated with each cylinder of the multi-cylinder internal combustion engine comprises the further step of measuring a top dead center characteristic of each
5 such cylinder.

9. The method of claim 6, wherein said step of measuring a physical characteristic associated with each cylinder of the multi-cylinder internal combustion engine comprises the further step of measuring an angular relationship between the cam
10 shaft and the crankshaft.

10. The method of claim 8, wherein said step of storing data in a computer comprises the further step of storing air-fuel data for determining an air:fuel ratio for each cylinder of the multi-cylinder internal combustion engine.

11. The method of claim 8, wherein said step of storing data in a computer
15 comprises the further step of storing fuel injection timing data corresponding to a duration of a fuel injection interval for each cylinder of the multi-cylinder internal combustion engine.

12. The method of claim 8, wherein said step of storing data in a computer
20 comprises the further step of storing fuel injection timing data corresponding to a start time of a fuel injection interval for each cylinder of the multi-cylinder internal combustion engine.

13. The method of claim 12, wherein said step of storing fuel injection timing data corresponding to a start time of a fuel injection interval for each cylinder of the multi-cylinder internal combustion engine comprises the further step of storing data
25 responsive to a timing of top dead center for each cylinder, the start time of the fuel injection interval for each cylinder of the multi-cylinder internal combustion engine being determined in relation to the top dead center of the associated piston.

14. The method of claim 12, wherein said step of storing fuel injection timing data corresponding to a start time of a fuel injection interval for each cylinder of

the multi-cylinder internal combustion engine comprises the further step of storing data responsive to a timing of an injector sensor-timing signal.

15 15. The method of claim 8, wherein said step of storing fuel injection timing data corresponding to a start time of a fuel injection interval corresponds to an average start time of the fuel injection interval for the plurality of cylinders of the internal combustion engine.

10 16. The method of claim 8, wherein said step of storing data in a computer comprises the further step of storing fuel injection timing data corresponding to an end time of a fuel injection interval for each cylinder of the multi-cylinder internal combustion engine.

17. The method of claim 8, wherein said step of measuring a top dead center characteristic of each such cylinder comprises the further step of measuring a top dead center characteristic of each such cylinder in response to angular displacement of the crankshaft.

15 18. The method of claim 8, wherein said step of measuring a top dead center characteristic of each such cylinder comprises the further step of measuring a top dead center characteristic of each such cylinder in response to a length a connector assembly between the piston and the crankshaft.

20 19. The method of claim 8, wherein said step of measuring a top dead center characteristic of each such cylinder comprises the further step of measuring a top dead center characteristic of each such cylinder in response to a distance between the top of the piston and the top of the corresponding cylinder.

20. The method of claim 8, wherein the top dead center characteristic corresponds to an angular characteristic of the crankshaft.

25 21. The method of claim 20, wherein the angular characteristic of the crankshaft corresponds to an angular relationship between a longitudinal axis of a connecting rod pin of the crankshaft and a longitudinal axis of the crankshaft.

30 22. The method of claim 20, wherein the top dead center characteristic is responsive to a difference between an external diameter of a connecting rod pin of the crankshaft and an internal diameter of a connecting rod.

23. The method of claim 8, wherein said step of measuring a top dead center characteristic of each such cylinder comprises the further step of measuring a top dead center characteristic of each such cylinder in response to a timing characteristic of the cam shaft.

5 24. The method of claim 8, wherein said step of measuring a top dead center characteristic of each such cylinder comprises the further step of measuring a top dead center characteristic of each such cylinder in response to an angular characteristic of the cam shaft.

10 25. A method of correcting engine performance in response to assembly deviations, the engine being an internal combustion engine of the type having an engine block with a plurality of cylindrical bores therein, a plurality of pistons accommodated within respectively associated ones of the cylindrical bores, a crankshaft, a plurality of connector assemblies for connecting respectively associated ones of the pistons to the crankshaft, a head assembly for forming a corresponding plurality of combustion
15 chambers, and a cam shaft rotatively coupled to the crankshaft, the method comprising the steps of:

measuring a top dead center characteristic of each piston of the internal combustion engine; and

20 storing data responsive to said step of measuring in a computer corresponding to each piston of the internal combustion engine.

26. The method of claim 25, wherein the data stored in said step of storing corresponds to the rate of injector fuel flow corresponding to each piston of the internal combustion engine as a function of crankshaft angle.

25 27. The method of claim 25, wherein said step of measuring a top dead center characteristic of each piston of the internal combustion engine comprises the step of measuring a top dead center characteristic of each piston of the internal combustion engine in relation to an angular orientation of the crankshaft.

30 28. The method of claim 25, wherein said step of measuring a top dead center characteristic of each piston of the internal combustion engine comprises the step of measuring a top dead center characteristic of each piston of the internal combustion

engine in relation to a distance of axial displacement of each piston within its associated cylindrical bore.

29. The method of claim 25, wherein said step of measuring a top dead center characteristic of each piston of the internal combustion engine comprises the step
5 of measuring a top dead center characteristic of each piston of the internal combustion engine in relation to a difference between an external diameter of a connecting rod pin of the crankshaft and an internal diameter of a connecting rod.

30. The method of claim 25, wherein said step of measuring a top dead center characteristic of each piston of the internal combustion engine comprises the step
10 of measuring a top dead center characteristic of each piston of the internal combustion engine in relation to a timing characteristic of the cam shaft.

31. The method of claim 25, wherein said step of measuring a top dead center characteristic of each piston of the internal combustion engine comprises the step
15 of measuring a top dead center characteristic of each piston of the internal combustion engine in relation to a timing of a fuel injection interval.

32. The method of claim 25, wherein said step of measuring a top dead center characteristic of each piston of the internal combustion engine comprises the step
20 of measuring a top dead center characteristic of each piston of the internal combustion engine in relation to a compression characteristic in each corresponding combustion chamber.

33. The method of claim 32, wherein the compression characteristic in each corresponding combustion chamber corresponds to a compression value.

34. The method of claim 32, wherein the compression characteristic in each corresponding combustion chamber corresponds to a rate of change of a compression
25 value.

35. The method of claim 25, wherein there is provided the further step of varying an air:fuel ratio for each piston during operation of the internal combustion engine in response to the data stored in response to said step of measuring a top dead center characteristic of each piston of the internal combustion engine.

36. The method of claim 25, wherein there is provided the further step of varying an air:fuel ratio distribution for each combustion chamber during operation of the internal combustion engine in response to the data stored in response to said step of measuring a top dead center characteristic of each piston of the internal combustion engine.

37. The method of claim 25, wherein there is provided the further step of varying a fuel injection interval start time for each piston during operation of the internal combustion engine in response to the data stored in response to said step of measuring a top dead center characteristic of each piston of the internal combustion engine.

38. The method of claim 25, wherein there is provided the further step of varying a fuel injection interval end time for each piston during operation of the internal combustion engine in response to the data stored in response to said step of measuring a top dead center characteristic of each piston of the internal combustion engine.

39. The method of claim 25, wherein there is provided the further step of varying the duration of a fuel injection interval for each piston during operation of the internal combustion engine in response to the data stored in response to said step of measuring a top dead center characteristic of each piston of the internal combustion engine.

40. The method of claim 25, wherein there is provided the further step of varying the timing of a fuel injection interval for each piston during operation of the internal combustion engine in response to the compression value of the associated combustion chamber.

41. The method of claim 25, wherein there is provided the further step of varying the timing of a fuel injection interval for each piston during operation of the internal combustion engine in response to the rate of change of the compression value of the associated combustion chamber.

42. An internal combustion engine of the type having an engine block with a plurality of cylindrical bores therein, a plurality of pistons accommodated within respectively associated ones of the cylindrical bores, a crankshaft having a plurality of

crankshaft connector pins, a plurality of connector assemblies for connecting respectively associated ones of the pistons to respectively associated connector pins of the crankshaft, a head assembly for forming a corresponding plurality of respectively associated combustion chambers, and a cam shaft rotatively coupled to the crankshaft, the cam shaft having a plurality of lobes each associated with a respective one of the combustion chambers, each cylindrical bore with associated piston, crankshaft connector pin, combustion chamber, and cam shaft lobe constituting a cylinder, the internal combustion engine comprising a computer having a memory for storing data responsive to the physical characteristics of each cylinder.

43. The internal combustion engine of claim 42, wherein the data responsive to the physical characteristics of each cylinder comprises engine control parameters for controlling predetermined operating criteria of each cylinder of the internal combustion engine during operation.

44. An arrangement for generating data for an engine control module, the arrangement comprising:

a first measurement arrangement for measuring axial displacement of a piston under test within the respectively associated one of the cylindrical bores and producing corresponding piston displacement data;

a second measurement arrangement for measuring radial displacement of a cam lobe associated with the piston under test and producing corresponding cam lobe displacement data; and

a control system for receiving the piston displacement data and the cam lobe displacement data and converting the piston displacement data and the cam lobe displacement data into respective engine control parameters.

45. The arrangement of claim 44, wherein there is further provided an injector data input for receiving data corresponding to the timing of injector pulses.

46. The arrangement of claim 44, wherein there is further provided a crankshaft data input for receiving data corresponding to the timing of the crankshaft throw.

47. The arrangement of claim 44, wherein there is further provided an engine control module burner arrangement for installing engine control data corresponding to the engine control parameters into a memory location of the engine control module.

5 48. The arrangement of claim 47, wherein there is further provided a display for displaying to a human operator information corresponding to the piston displacement data, the cam lobe displacement data, and the engine control data.

49. The arrangement of claim 47, wherein there is further provided in said control system a data storage location for storing limit data for determining whether the engine control parameters signify an engine condition that is out of tolerance.